Selection and Eugenics

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WHEN CHARLES DARWIN pointed out the role that natural selection of certain genetic types has played in the evolution of animal and plant species, it was soon realized that modern man may be subjected to similar selective influences. As a result, two slightly different considerations were advanced, each complementary to the other. One dealt with the changes in natural selection that civilization has brought about. Darwin had stressed the ruthless struggle, in which the genetically less fit has a poorer chance of reproducing his kind than the more fit. Did not civilization reduce or eliminate this selection against the less fit by improving his chance of reproduction through charitable care, or artificial remedies? Had not an ominous situation been created which would lead to an increase in undesirable genetic constitutions? But to counteract this pessimistic view another possibility fired the imagination toward hopeful perspectives. Could not man take the genetic fate of the species into his own hands? Could he not be more efficient and successful than nature, and by the use of his knowledge improve the genetic qualities of future generations? Francis Galton coined the word *eugenics* to cover the whole "study of agencies under social control that may improve or impair the racial [meaning hereditary] qualities of future generations, either physically or mentally."

In accordance with its two aspects, the field of eugenics has often been subdivided into two branches, called negative and positive eugenics. The first is concerned with combating the increase or the presence of alleles or of genic combinations producing undesirable phenotypes, the second with furthering the increase of alleles or combinations causing desirable phenotypes, or at least guarding against the decrease of such genotypes.

The facts that eugenists use as a basis for the discussions are worthy of the most serious attention. While estimates of the frequencies of subnormal traits, physical or mental, are not very accurate, the total number of affected individuals in the United States amounts to many millions. Of course, only in some of these individuals are the subnormal conditions due to heredity causes, but the sum of genetically defective persons may well be much larger than one million.

It is customary in this connection to emphasize what it costs the public to care for defectives. Some decades ago, a number of studies were published of families who, in the course of generations, had contributed a large number of undesirable individuals to the population of the United States. The Jukes and the Kallikaks—literary names assigned to these families—became household words in the discussion of eugenic problems. The recurrence, generation after generation, of various types of criminality and of mental deficiency was taken as proof of the hereditary nature of these traits. It is now recognized that the methods used in gathering these family histories were highly uncritical and that these studies therefore give a distorted picture. Moreover, even if the data were unbiased no valid conclusions regarding the genetic component of the traits in these families can be drawn, since it is impossible to judge separately the parts played by genetic factors and by the very unfavorable environments which persisted generation after generation. As for the cost to society of these families, who instead of adding to its economy required support from it or were directly destructive to its assets, it was estimated as amounting over the years to millions of dollars. The significance of such sums, however, must be judged in terms of the total national expenditure. Although any unproductive expenditure is undesirable, the costs of caring for defectives are small relative to the sums involved in the whole economy.

It is often stated that physical defectives, and especially the "insane," are on the increase in Western nations. If this implies that the absolute numbers of such persons are increasing, this may well be so, since populations have also increased. A statement of this kind is meaningful only when it refers to the relative frequency of defectives in the population. When the facts are stated in relative terms it is indeed found that the relative number of patients *in institutions* has steadily increased, but the interpretation of these data is by no means obvious.

This rise may reflect a change in attitudes and in opportunities for social care. Whereas in former times the mentally ill were kept at home, they are now sent to hospitals. Better diagnosis and better methods of obtaining full reports also result in adding to the census of defectives. In Sweden, with its highly developed census system, 4,349 epileptic individuals had been registered in 1940. Medical examination of

all Swedish men reaching the age for conscription, however, placed the total number of epileptics at about 12,000, indicating that the census had unearthed less than 40 percent of them. Apparently the accuracy of the census data depended on the willingness of people to divulge relevant information to the authorities. Dahlberg, to whom we owe this example, concluded that "there is plenty of room for an increased frequency through improved registration, even if the actual frequency of hereditary epilepsy were to decrease appreciably" (*1*).

One more factor may be mentioned that enters into an interpretation of increased frequencies of certain defects. Many pathological conditions, among them certain types of mental derangement, as well as organic diseases like cancer and diabetes mellitus, tend to make their appearance in the later periods of life. Without the recent prolongation of man's average life span, many persons who now reach an older age and become affected formerly would not have lived to the necessary age and would not have swelled the number of recognized defectives.

The greatest concern expressed by eugenists is that the intellectual genetic endowment of Western populations is in danger of decreasing. This fear is based on the fact of differential fertility. If, for instance, the population of the United States is subdivided into different categories, according to occupation, educational background, income, or in other ways, it is found that the average number of children per family is different for the different groups. The striking fact regarding the average reproduction of the different categories is that it decreases with increase in socioeconomic status, as shown in Table 1.

The differential fertilities of groups of different socioeconomic status are of no concern to the geneticist if the genetic endowments of the different layers of the population are alike—that is, by and large, if the same allele frequencies for all loci hold for the different groups. If, on the other hand, different layers differ in their corporate genetic make-up, then differential reproduction constitutes a selective agent.

TABLE 1

RATIO OF THE NET REPRODUCTIVE RATE FOR SPECIFIC URBAN CLASSES TO THE CORRESPONDING RATE FOR THE TOTAL URBAN WHITE POPULATION OF THE UNITED STATES, 1935–1936*

Education of mother	Reproductive ratio
College	0.74
High school	0.97
Seventh or eighth grade	1.23
Less than seventh grade	1.39

* After Karpinos and Kiser (*2*).

We cannot say now with any certainty whether or not different socioeconomic groups are genetically differentiated. The difficulties of research in this important field are great. The concept of socioeconomic levels itself is subject to various definitions, involving occupation, social prestige, amount of income, education, etc., and a simple scale of levels does not represent actualities satisfactorily. These, however, are minor difficulties as compared to finding out whether different groups are or are not genetically alike. It might be not too difficult to obtain data on this problem as related to various physical traits. But the question is primarily concerned with mental traits,

TABLE 2

AVERAGE I.Q. IN THE CHILDREN (18–54 MONTHS OLD) OF FATHERS OF DIFFERENT OCCUPATIONAL LEVELS IN THE UNITED STATES*

Occupation of fathers	Average I.Q.
Professional	125
Business, clerical	120
Skilled workers	113
Semiskilled workers	108
Unskilled workers	96

* After Goodenough (*3*).

since these may possibly be correlated with the socioeconomic status of the individuals. Mental traits are expressed very differently, according to environmental conditions—in the widest sense of the term environment. Undoubtedly, a large part of the variability in mental traits among human beings of different levels is therefore attributable to differences connected with their being in different environments as represented by these levels. Psychological tests which measure mental differences are imperfect indicators of the genetic nature of such differences, since psychologists have not fully succeeded in devising tests that are equally intelligible to individuals who have grown up in different social surroundings. Even with these imperfections of the tests in mind, however, there is evidence that strongly suggests hereditary influence.

Intelligence tests of the children of parents belonging to different socioeconomic levels show a rather consistent phenomenon, whether, for instance, based on studies made in the United States (Table 2), or in Soviet Russia (Fig. 1). The mean scores decline consistently from groups of higher levels to those of lower levels. How much of this decrease is environmentally conditioned is difficult to evaluate. Various lines of evidence, however, particularly studies of twins reared together as compared with others separated early in life, and on the intelligence scores of adopted children in relation to occupational status of the foster father and as compared with own children

make it hard to avoid the conclusion that environment is not the sole agent and that there *are* mean differences in the genetic endowment of different socioeconomic groups.

At each level scores vary greatly, much more than do the mean scores of the different levels. The result

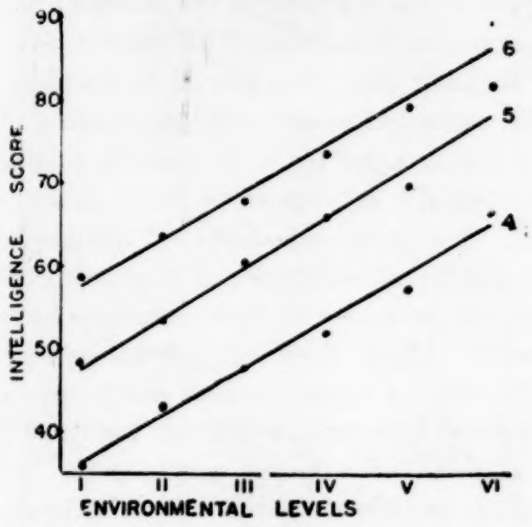

FIG. 1. Mean scores in intelligence tests administered in Charkow (USSR) to pupils in grades 4, 5, and 6, according to environmental levels as judged by parental education. Environment I applies to children of workers, one or both of whom were illiterate, VI children of officials who had university education (5).

of this intragroup variability is that an individual from a high level with a score at the average of his group will be surpassed by a great many individuals from a lower level; and, conversely, that an individual from a lower level with an average score for his group will be superior to many individuals of a higher level. The fact that there is a wide spread in I.Q. scores within each group mirrors to some extent the fact that different homes provide very different environments. Undoubtedly the spread in I.Q. scores is also owing to hereditary differences which express themselves in varying capabilities even within a single socioeconomic group.

Investigations restricted to the subnormal categories of intelligence point to the same conclusion. It was found in several studies that the relative frequency of feeble-minded children was considerably higher in the lower socioeconomic groups than in the upper ones. Thus the lower average I.Q. scores of the lower levels is in correlation with the greater frequency of very low I.Q. scores among the children. This correlation undoubtedly has an environmental component in that the restrictions of a lower socioeconomic status tend to relegate a child of low intellectual potentiality to the feeble-minded group whereas the opportunities provided by a higher status would tend to shift the same child into the range of better I.Q.'s. It seems unlikely, however, that such environmental factors are solely responsible for the high rate of feeble-minded children in the lower levels. It is more likely that the segregation of genetic constitutions involved in low I.Q. scores in the parents results not infrequently in genotypes among the children that place them in the range of feeble-mindedness. Probably, too, expression of genetic constitutions involved in low scores may vary from feeble-mindedness on up and the same genotype that in a parent permits somewhat higher intelligence may produce some feeble-minded children.

To reach the conclusion that there are probably genetic differences in intellectual endowment of the different socioeconomic levels is one thing, but to determine the specific type and magnitude of these differences is quite another. Undoubtedly, the differences are not absolute in the sense that any layer of a population is in the exclusive possession of alleles effective in the control of intelligence. There are no sharp boundaries between layers, since many individuals in each generation rise from a lower to a higher status, while others fall from a higher to a lower status. Some of these shifts may be explained by genetic segregation—of better genotypes in the lower levels and of poorer genotypes in the upper levels—but even if this interpretation should be true, there is a lag brought about by environment that keeps many with higher genetic endowment from rising and others with lower endowment from falling.

Whatever the genetic details and however important they may be for a complete insight, one fact is already apparent: If there are genetic differences between different socioeconomic layers, then differential fertility will result in selective increase of some allele frequencies, and decrease of others in the population as a whole. Since the differential fertility acts in favor of high reproduction of the intellectually more poorly endowed groups, and against high reproduction of the bettter endowed groups, a deterioration of the genetic endowment of the population should result.

The degree of this deterioration from one generation to the next could be determined only on the basis of exact data on the genetic basis of the intelligence scores and their nature-nurture interdependence. Lacking such data, attempts have been made to calculate expected phenotypic changes—that is, in the I.Q. scores—in successive generations. Using the observed mean scores in different socioeconomic levels and the observed reproductive values of these levels, various authors have arrived at estimates for the decrease in I.Q. for the population as a whole, from the present generation to the next. These estimates vary from about one to around five points. The calculations are based on many uncertainties and cannot be checked with observation, since no actual tests of successive generations have yet been made.

Historically, differential reproduction, on a large scale, of the type under discussion is a rather recent phenomenon. It is primarily the result of birth control, which became an important social practice in the second half of the 19th century. Since birth control measures are more frequently used by the upper and middle groups of Western countries than by the lower ones, the limitation of births becomes a selective process. There is reason to believe that the use of contraceptive measures will spread over the population as a whole and that the differential in the fertility of different groups will be diminished. From a eugenic point of view such a result is desirable.

There is a possibility that the differential fertility of the different groups is less significant even now than it appears. Some data indicate that the most successful members of the upper groups (success being estimated in various ways) are more fertile than the less successful ones. The reasons for this higher fertility may be related at least partially to the favorable financial status of these successful families, which permits them to bring up children under good conditions without undue strain. If the relatively high fertility of the upper subgroups within the higher levels should be a general phenomenon, and if success *within* a group is positively correlated with intellectual genetic endowment, then the higher fertility of the most successful would counteract, to an unknown degree, the low fertility of the group as a whole.

No studies have been made which give information on the fertility of different subgroups within the middle or lower groups. It does not seem unlikely that here the correlation between success and fertility is again negative. In the upper subgroups of the lower or middle groups, with their relatively small financial resources, the desire to provide for one's children the most favorable conditions may lead to particularly stringent birth limitation.

It is likely, then, that the present differential fertility of the different groups has a dysgenic effect in regard to intelligence. But the question may be raised whether there are desirable mental traits under gene control whose frequencies may be positively correlated with fertility. The upper layers of Western societies apparently have a relatively high frequency of genetic constitutions favoring intelligence, but they seem to be no better off than other strata in their frequency of alleles which lead to idiocy. Could there be still a third type of genetically controlled mental traits for which the upper groups are relatively deficient, but which constitute assets to the individual and to society? An answer to this question cannot be given. It would depend on many factors, of which only a few may be mentioned. The first difficulty arises in defining a desirable trait. Emotional stability might be desirable, but it is a trait that does not accompany many types of genius which enrich civilization. Altruism may be another desirable trait, but acquisitiveness and egocentric ambition have not produced misery exclusively but have also led to advances which have contributed to the welfare of the masses. It will be hard to agree on definitions of desirable traits—and it is clear that the ideal does not lie in uniformity.

Even if some agreement could be reached, a second difficulty is that measures of the genetic component of men's variability in regard to these traits are not available. The social plasticity of mankind is very great and different societies and groups within societies mold the attitudes of their members in most diverse ways. Many facts of psychology show that cooperativeness or aggressiveness can be produced by environmental influences acting on the same individuals, but these facts do not preclude the possibility that certain genetic components, yet unknown, may bring out one particular trait more readily than certain others.

There is some relevant evidence from two genetically different strains of laboratory mice. Under certain conditions, the males of one strain react peaceably to a strange mouse and the males of the other strain are highly aggressive. Yet within a few days specific training can transform both types of mice into either peaceful or fiercely fighting individuals.

We have stressed the tentative nature, and the frequent absence, of knowledge regarding the genetic basis of differences among human beings. Even if the information were more complete we would still have to make a detailed investigation of the effects selective agents would have on the genetic and phenotypic composition of later generations, before we could fully understand the dynamics of populations. A few theoretical situations will be discussed in which selection for or against various genotypes is active.

The simplest situation is that of selection against a single factor, autosomal dominant genotype *DD* or *Dd*, or conversely, selection for a recessive genotype *dd*. Practically all persons carrying a rare dominant allele are heterozygous, so that we may restrict our discussion to a population consisting of only *Dd* and *dd* individuals. If the dominant allele is fully penetrant and causes its phenotypic effect to appear before the reproductive age has been reached, then suppression of reproduction of all affected individuals will lead to elimination of the dominant condition from the next generation (Fig. 2, dotted line) except for new mutations from the recessive to the dominant allele. If, on the other hand, selection, in terms of suppression of reproduction of *Dd* individuals, acts only on some

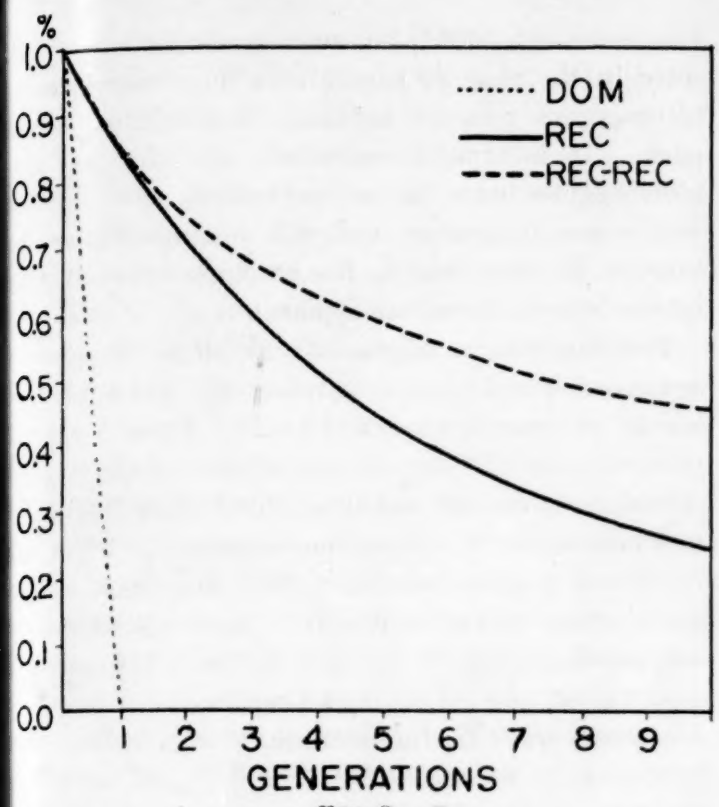

FIG. 2

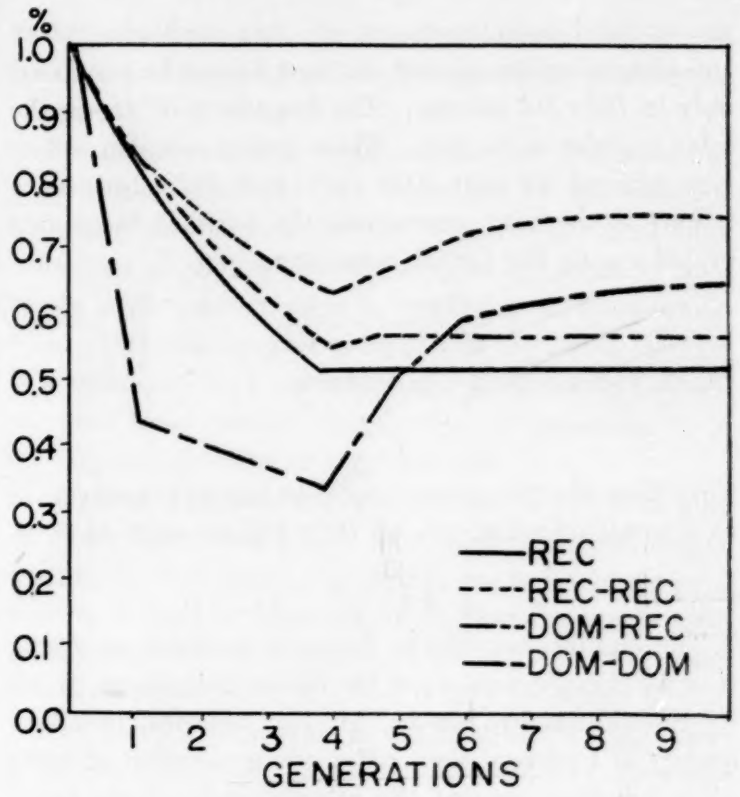

FIG. 3

FIG. 2. Complete selection for ten successive generations against a rare dominant genotype (Dom), a recessive (Rec), and a double homozygote (Rec-Rec). Initial frequency of the selected genotypes 1% (*3*).

FIG. 3. Complete selection against certain genotypes for four successive generations and cessation of selection during the following six generations. Rec = homozygous recessives; Rec-Rec = double homozygotes (e.g. $A^2A^2B^2B^2$); Dom-Rec = dominant phenotype in regard to one pair of alleles, recessive in regard to a second pair (e.g. *AAbb* and *Aabb*); Dom-Dom = dominant phenotype in regard to two pairs (e.g. *AABB*, *AaBB*, *AABb* and *AaBb*) (*3*).

and not on all these individuals, either because penetrance is incomplete or for other reasons, then a fraction of affected persons will reappear in successive generations. If, for instance, half of the carriers of a dominant allele are selected against, while the other half reproduce at the rate of the genetically normal population, the number of carrier individuals will be reduced to one-half in the first generation following selection, to one-quarter in the second, and in general to $(\frac{1}{2})^n$ of the original number where n equals the number of generations.

Complete selection against a single dominant factor is thus 100 percent effective in a single generation, and even partial selection accomplishes much. For example, with a selection factor of one-half, the number of dominants is reduced to a little more than one-tenth of the original number in three generations, and has practically disappeared in ten generations. If, for instance, all dominant chondrodystrophic dwarfs, or all individuals with dominant juvenile cataract would not reproduce, then the unhappiness caused by the birth of affected individuals in these families would be completely eliminated in one generation. For dominantly inherited diseases like Huntington's chorea, which often sets in after the reproductive age has begun, the reproduction of the disease through cessation of procreation by phenotypically affected persons will follow the experimental decrease.

Even with incomplete penetrance of a dominant allele, a complete elimination in one generation could be accomplished if *all* children who had an affected parent remained childless, regardless of whether they were phenotypically healthy or affected. This would involve not only the *Dd* individuals who might later become diseased, but also their *dd* sibs who are genetically normal. Such a situation is fraught with tragedy. A person who knows that he is the carrier of a genotype that leads to a very serious disease later in life will undoubtedly not wish to risk the chance of producing potentially affected children, but the personal sacrifice in remaining childless will appear very heavy if the potential parent finds out later in life that he was free from the dreaded allele. A means of distinguishing between *Dd* and *dd* individuals when both are still normal would be of great benefit to such people.

Selection against a single-factor, homozygous, autosomal genotype *dd*, or conversely, selection for a dominant *DD* or *Dd*, is less effective than the type of selection just discussed. The decrease of *dd* individuals from one generation to the next in a population in which all *dd* adults have been excluded from procreation can be calculated on the basis of the known frequencies of the alleles *D* and *d*. If the two frequencies are p and q respectively ($p+q=1$), then the frequencies of the three genotypes *DD*, *Dd*, and *dd* in

the original population are p^2, $2pq$, and q^2. After complete selection against *dd*, new *dd* can be produced only in $Dd \times Dd$ unions. The frequency of *Dd* in the total population is $2pq$. Since under complete selection against *dd* only *DD* (p^2) and *Dd* ($2pq$) contribute to the next generation, the relevant frequency of *Dd* among the *fertile* population is

$$\frac{2pq}{p^2+2pq} = \frac{2q}{p+2q}$$

which, because $p = 1 - q$, becomes

$$\frac{2q}{1+q}.$$

Therefore the frequency of *dd* in the new generation as a result of marriages of $Dd \times Dd$, amounts to

$$(q_1)^2 = \frac{1}{4} \cdot \left(\frac{2q}{1+q}\right)^2 = \frac{q^2}{(1+q)^2} \qquad (1)$$

The significance of the formula becomes apparent if some specific values for the initial frequency, q^2, of *dd* individuals are used. If, for instance, this frequency is 1 percent then, after one generation of complete selection against the affected individuals $(q_1)^2$ amounts to 0.83 percent. If the initial frequency is 0.83 percent, selection in one generation will reduce it to 0.69 percent; if the initial frequency is 0.01 percent the reduction will lead to 0.009803 percent.

These figures show two main facts: (1) that the lowering of the frequency is only a fraction of any initial frequency and (2) that the relative efficiency of selection against recessives lessens with a decrease of the initial frequency. The second point is well illustrated by a comparison between the first and last examples. The reduction from 1 to 0.83 percent represents a lowering of the initial frequency of *dd* by 17 percent, while the reduction from 0.01 to 0.009803 percent represents a lowering by only 2 percent.

This decrease in the effectiveness of selection against recessives with a lowering of the initial frequency is of great significance if one considers the results expected from selection continued over many successive generations. In Fig. 2 (continuous line) the results of selection over ten generations are given, starting with an initial frequency of 1 percent. It can be seen that the reduction in frequency of *dd* becomes less in each successive generation and that, after ten consecutive generations of total selection, it is still nearly one-quarter of the initial frequency of 1 percent. To reduce it to one-tenth, that is 0.1 percent, would require 22 generations. If the selection against recessives is not complete but reduces the average reproduction of *dd* individuals to some fraction of the normal rate, then obviously the effect of the selective process is even less.

Selection would be more effective if it included not only the homozygotes themselves but also certain of their close relatives who are likely to be heterozygotes. The immediate effect, however, would be very small, since in the case of rare alleles most marriages of heterozygous persons are with homozygous normal ones. It is true, nevertheless, that for any two heterozygotes who do not reproduce, two recessive alleles are eliminated, and this elimination, on the average, is equivalent to the nonappearance at some future time of one affected person.

The foregoing analyses of the effect of selection against simple dominant or recessive traits apply primarily to specific abnormal traits. From a general point of view, the significance of these traits is small if compared to such traits as intelligence, for which a whole series of expressions exists and which are rightly of greater concern to the student of human genetics and to the sociologist. These quantitatively varying traits, insofar as their variation is genetically conditioned, are the results of expression of *multifactor genotypes*. If, for instance, a trait is controlled by two pairs of genes A^1, A^2 and B^1, B^2, then nine different genotypes may be present in the population: $A^1A^1B^1B^1$, $A^1A^2B^1B^1$, $A^1A^1B^1B^2$, $A^2A^2B^1B^1$, $A^1A^1B^2B^2$, $A^1A^2B^1B^2$, $A^2A^2B^1B^2$, $A^1A^2B^2B^2$, and $A^2A^2B^2B^2$. If $A^1A^1B^1B^1$ and $A^2A^2B^2B^2$ are phenotypical extremes—for example, if they represent the lowest and highest endowment in the population—and if every substitution of A^2 for A^1, or of B^2 for B^1 increases the endowment to a certain degree, then nine different degrees of endowment will exist.

The results of selection against one or more of these multifactor phenotypes are different from those against single-factor genotypes. This may be seen in Fig. 2 (broken line), which shows the decrease of $A^2A^2B^2B^2$ individuals during ten consecutive generations of complete selection against this type. From an assumed initial frequency of 1 percent the frequency drops after one generation to 0.83 percent—just as in selection against a single-factor type *dd*. However, in later generations the decrease of $A^2A^2B^2B^2$ is much less than of *dd*. After ten generations the $A^2A^2B^2B^2$ class still recurs in 45.5 percent of its initial frequency, in contrast to 25 percent of the *dd* class. The slower progress in the transformation of a population in case of multifactor as opposed to single-factor inheritance is owing to the fact that the populations contain different frequencies of carrier individuals. In single-factor inheritance only the heterozygous *Dd* individuals form a reservoir from which a *dd* may be reconstituted. In two-factor inheritance against $A^2A^2B^2B^2$ *all* genotypes except $A^1A^1B^1B^1$ are carriers for one or the other, or for both of the alleles A^2 and B^2 against whom selection is directed. In a population which contains 1 percent *dd*, 18 percent are *Dd* carriers; but in a population

which contains 1 percent $A^2A^2B^2B^2$, 77.1 percent are $A^1A^2B^1B^1$, $A^1A^1B^1B^2$, $A^2A^2B^1B^1$, $A^1A^1B^2B^2$, $A^1A^2B^1B^2$, $A^2A^2B^1B^2$, or $A^1A^2B^2B^2$.

In single-factor inheritance with random mating, a change in an allelic frequency as a result of selection immediately leads to the establishment of a new constant distribution of the three genotypes *DD, Dd,* and *dd*. This is an expression of the Hardy-Weinberg rule, p^2 *DD*: 2 *pq Dd*; q^2 *dd*. This immediate establishment of an equilibrium implies that a lower frequency of *dd* attained after selection will remain at its level after selection ceases. It was Weinberg himself, however, who realized soon after his discovery of the situation relating to one gene pair, that for multiple pairs, if the equilibrium were disturbed, a new equilibrium would be established only gradually. This may be shown for the $A^2A^2B^2B^2$ class. After one generation of selection this class is reduced from an initial frequency of 1 percent to 0.83 percent. If selection is discontinued, reconstitution of the class from the large reservoir of carrier individuals leads to a new rise, which gradually brings its frequency up to 0.91 percent—that is, to a recovery of nearly one-half of the originally lost frequency.

This "comeback" phenomenon in two-factor pair inheritance is obviously not restricted to cases in which selection ceased after one generation. Fig. 3 shows its existence and extent for some other examples, giving the changes in the frequencies of various phenotypes after complete selection had acted for four generations and then ceased.

Multifactor inheritance is usually based on many more than two pairs of factors. The foregoing discussions, modified, apply also to inheritance involving three or more pairs. Since in a population the frequency of individuals who are carriers for at least one of the alleles concerned in selection increases with the number of loci, the speed with which selection permanently accomplishes specific results decreases with increasing number of loci.

The numerical data presented for selected cases of multifactor inheritance are examples of the kind of information needed for a detailed understanding of the effect of differential fertility in man upon the phenotypic and genotypic composition of later generations. The model examples used in our discussion cannot be regarded as representing adequately the still unknown genetic situation in respect to such traits as performance in intelligence tests, or other genetic components believed to participate in the variability that places different individuals into different socioeconomic layers. It already seems possible, however, to say that genetic changes brought about by selective events are small from one generation to the next, and that the effectiveness of selection cannot be judged solely from a consideration of immediate phenotypic changes.

The effectiveness of selection has been discussed for populations which at the beginning of the selective processes were in equilibrium. Specific alleles or combinations of alleles, however, frequently occur in relatively high concentration in "pockets" of the population. The efficiency of selection is *increased* if there is a relatively high concentration of alleles in isolates, or more than random frequencies of homozygotes or of selected multifactor combinations.

In another respect the effectiveness of selection may often be *lower* than predicted at first. If an inherited trait has a certain frequency in a random mating population it must be ascertained whether the appearance of the trait is due to alleles at the same locus in each affected individual or whether it may be caused by different loci. If the trait is the result of two or more different genotypes based on different loci, then the effect of selection has to be considered separately for each genotype.

This may be shown by an example. Assume a population in which 1 in 10,000 individuals is blind for genetic reasons—that is, a frequency of 0.0001. If the blindness of all individuals were caused by the same homozygous recessive allele, then one generation of selection against the trait, according to equation 1, would reduce its incidence to 0.00009803. On the other hand, if there were ten different, and equally numerous genotypes, each of which produces blindness, then the initial frequency of any one of them would be one-tenth of 0.0001 or 0.00001. Selection, for one generation against each homozygous genotype, would reduce it to 0.000009937, so that the frequency of the sum of all individuals affected with any one of the ten genotypes is 0.00009937. Selection against the trait would thus lead to a reduction of only 0.63 percent of the original frequency as compared to 1.97 percent when a single genotype is involved. This hypothetical example is probably representative of many actual situations, since many results suggest that similar or apparently identical hereditary phenotypes are the result of diverse genetic constitutions.

The slowness of selective processes against recessive single factors and against multiple factors is both a blessing and a curse. It is a fortunate feature in that it forms a powerful buffer against sizable, undesirable effects of selection, as in differential fertility directed against intellectually well-endowed groups. It is an unfortunate feature in that selective measures aimed at eliminating undesirable traits are rendered relatively ineffective. In either respect the population at large serves as a huge reservoir for alleles from which

the desirable and undesirable genotypes can be reconstituted.

If the hopes and fears of the eugenic movement seem greatly exaggerated in the light of a numerical treatment of the problems, it should not be forgotten that the idealism which concerns itself with the genetic fate of future generations has a sound core. To say that the loss of supposedly desirable genotypes in one or even many generations of differential fertility is small does not remove the fact that it *is* a loss, which may be regrettable and possibly even have serious consequences. Although reproductive selection against severe physical and mental abnormalities will reduce the number of the affected from one generation to the next by only a few percent, nevertheless these few percent may mean tens of thousands of unfortunate individuals who should not be born. Conversely, even a slight increase of desirable genotypes, through positive eugenic measures, would be a social gain.

Eugenic and dysgenic selection are concerned with genetic constitutions which under present physical, mental, and social circumstances may lead to desirable or undesirable phenotypes. Since many genotypes express themselves differently under different environmental conditions it is possible that new kinds of environments can make genotypes which now lead to undesirable phenotypes shift their developmental reactions so as to result in desirable phenotypes. Thus, if a certain genotype formerly caused the serious disease diabetes mellitus, by way of a deficiency in internally produced insulin, the same genotype can now be made compatible with nearly normal living, by means of injection with insulin. Or it may be assumed that one genotype gives its carriers, in their specific educational and social environment, a lower I.Q. than another genotype gives to other individuals in their different environment. In spite of these circumstances, it might be possible to bring the carriers of the "lower" genotype to the same high achievement or even higher than the others, by means of a particularly appropriate environment.

Does substitution of a special environment to make up for deficient gene function necessarily lead to a weakened constitution of mankind? This question is frequently asked, and if it means that man may become more dependent on his environment than he was when all deficient genotypes were wiped out by natural selection the answer is yes, as far as the specific trait is concerned. Such dependence on special environments, however, did not start with the advent of civilization. When, in earliest evolutionary times, animals first developed, a new dependence of organisms on the environment arose. Instead of being able to synthesize their protoplasm from inorganic sources, animals had to rely on other organisms for food. When, much later, man's ancestors lost most of their mammalian body hair another, but this time minor, step was taken. Man had to rely on fur from other mammals and on fire to keep his temperature at the necessary physiological level.

In no instance, however, has man's greater dependence on specific outside sources for his survival been equivalent to degeneration. On the contrary, the dependence has often resulted in greater freedom from the restrictions of the external world. The loss of ability to use inorganic material for food became correlated with the evolution of nervous systems and sense organs, which make possible the many autonomous adjustments of animals. The dependence on clothing and fire enabled man to occupy regions of the globe where he could not have survived earlier. The passing of the primitive stages, in which each man was to a large extent independent of the help of others, gave rise to the complex interdependence of men in modern civilization. This new dependence has released man from the physical and mental starvation of earlier times. It is true, however, that man's freedom from his many limitations can persist and grow only if he retains and extends his slowly acquired control over his environment and over himself.

Human genetics concerns our own as well as future generations. Genetic counseling is largely devoted to individual problems, but the social implications of specific advice usually have not been disregarded. Eugenic thinking has always emphasized the well-being of mankind, even though much eugenic counseling was based on inadequate knowledge and has been harmful. In the future more knowledge will be gathered and will aid wise planning. Then genetic and eugenic counseling will become the foundation of human genetic engineering. Although eugenic problems are not as urgent as the pessimists believed, their ultimate importance can hardly be overestimated.

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This article is a condensed version of the chapter on selection and eugenics in Dr. Stern's forthcoming book, Principles of human genetics, *to be published by W. H. Freeman and Company in September.*

Research Publication: A Federal Responsibility?

Marion A. Jurgens

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THE NATION'S POSTWAR BUDGET for research and development during 1947 reached the highest point in our history—more than $1.1 billion." Thus John R. Steelman reports to President Truman in "Science and Public Policy" on the unprecedented volume of our national research effort (*2*).

This is a staggering figure when viewed against a total national research expenditure in 1930 of $166 million and of $345 million in 1940. Over a period of 17 years the national budget for research and development has increased more than 560 percent. Steelman recommends further that "our national expenditures for research and development should increase as rapidly as possible. By 1957, we should have at least doubled our present budget for this purpose" (*3*).

If Steelman were making his report today, he would have the federal expenditures on atomic energy research and development to add to the total. Officials of the Atomic Energy Commission estimate that approximately 300 million dollars of their federal appropriation are now spent annually on scientific research, exclusive of construction, weapon development, and administrative costs. This raises the total annual national expenditure for research and development to well over the billion dollar mark.

Research vs. Publication

For the cause of science, this calls for rejoicing. But something has been overlooked. The scientific journals—in which results of this tremendous research effort would normally be published—have not kept up either in volume or in scope with the increase in research. On the contrary, these journals have been beset by rising printing costs and overtaxed by the amount of good scientific material crying to be published.

To make matters very much worse, most research expenditures are made by the federal government and publication in the government, by tradition, has been viewed rather dimly because Congress frowns on publicity by government agencies. Although scientific publication is a necessary part of research and a far cry from publicity, the bad connotation of publishing by the government persists. This is unfortunate, for science rests upon its published record, and this record is of the utmost importance.

ONR-AEC Policy

It is interesting to note the stand taken in this respect by two government agencies which today figure most importantly in scientific research—the Office of Naval Research and the Atomic Energy Commission. ONR's publication policy has been stated as follows: "The most appropriate means of disseminating results of sponsored research is by publication in the recognized scientific channels." The AEC, in its Fifth Semiannual Report, says: "The Commission's policy is to encourage the use of normal channels for the release of scientific and technical information" (*8*). Both agencies have adopted this policy because they believe the normal channels for scientific publication have been tested by time and found acceptable. But the policy has now proved inadequate.

Let us review effects of this policy. The Royal Society Scientific Information Conference, held in London last sumer to examine the scientific publication problem on an international scale, listed these major effects of the existing publication system of scientific papers:

1. *Absolute loss of knowledge.* Many papers are never seen by the workers who could make use of their findings and who are therefore obliged to discover the results for themselves.

2. *Relative loss of knowledge.* Owing to delays in publication, abstracting and distribution, scientific papers often reach interested workers long after their publication, occasionally as long as three years. This delay slows down the whole circulation of science and also leads to unnecessary duplication.

3. *Inconvenience,* due to loss of research time in searching for literature and for this purpose reading through masses of irrelevant information.

4. *Increasing cost of publication,* which in turn has three consequences:

   a. Reducing the possibility of full publication of scientific material

   b. Crippling scientific societies by so adding to their subscriptions that they lose membership, and consequently

   c. Depriving the students of poorer finances of the possibility of membership of these societies.

5. *Loss of scientific, clerical, and technical manpower* in directing and administering an extremely complicated

and overlapping series of small undertakings producing scientific literature.

The report concludes that "these obstructions to scientific progress are plain and obvious" (*5*).

These, then, are some of the recognized universal effects of the existing system of scientific publication. ONR and AEC, in recommending use of this system, as it now exists, are recommending use of an inadequate system, but are severely limited in authority and resources to make it more adequate. At the same time they are burdening the scientific press by adding to the volume of papers it must handle.

To illustrate specifically what is happening to the normal channels for scientific publication, let us examine journals in two very important fields: physics and the biological sciences.

Physics. The American Institute of Physics publishes the following journals: *Physical Review, Reviews of Modern Physics, Journal of the Optical Society of America, Journal of the Acoustical Society of America, American Journal of Physics, Review of Scientific Instruments, Journal of Chemical Physics,* and *Journal of Applied Physics.* The first five are published by the Institute for member societies and the last three are the property of the Institute. About a year ago the Institute started a semitechnical publication, *Physics Today.*

The Institute is trying to cope with its increased publication costs by using a standardized format for all of its eight technical journals, by lowering typographical standards somewhat, and by expecting authors (or their laboratories) to make an appreciable contribution towards the cost of publication. Such aid is asked on the grounds that this cost is small compared with that of the research described, and that it encourages brevity of presentation. This policy is implemented by giving no free reprints and by charging a high price for any number up to 150. Price of reprints ranges from $11.90 for 150 reprints of articles of 1–4 pages to $59.50 for an article of 17–20 pages. An additional $7.50 is charged for covers. Alternatively, authors may elect to pay a publication charge of $4 per page. In this case they are entitled to 100 "free" reprints (without covers), and the price of further copies is then obtained by deducting that of the first 100 from the prices quoted above. In practice, the latter option is decidedly more expensive for the author. It is nevertheless the one that he is expected normally to adopt as a means of meeting part of the costs of publication.

The authors are also expected to prepare any diagrams included with the paper in a form suitable for immediate publication. The American Institute of Physics offers no facilities for redrawing. Poor diagrams are returned to the authors, and the result is delay of publication.

The author is expected not to make changes after his article has reached the galley proof stage, and is charged $3 per hour for editorial corrections.

In spite of these restrictions, physicists are publishing at an increasing rate. Henry A. Barton, director of the American Institute of Physics, reporting on the financial difficulties of the *Journal of Chemical Physics,* says: "The budget was balanced in 1948 only by 'holding over' some 200 pages ready for publication . . . to catch up and keep up with the accelerated flow of material meeting the editorial standards of the Journal, 2000 pages are needed for 1949." In 1944, 596 pages had been adequate.

Dr. Barton continues: "The estimated total income of the Journal for 1949 is $30,000, which falls $20,000 short of providing for the demand. . . . To meet the need of the *Journal of Chemical Physics* and others of a like nature, the Institute would have to budget such large deficits as to exhaust its total financial reserves in eighteen months. Obviously a more durable solution must be found. Meanwhile the Executive Committee of the Institute must very reluctantly restrict the page budget for 1949 to a figure much lower than 2000. . . . It is hard to overstate the seriousness of the present situation" (*1*).

How much of all this should be of concern to the government? A count of all articles and letters-to-the-editor appearing in the *Physical Review* over a six-month period last year revealed that fully a third were reports on government-sponsored research. There is no way of estimating what percentage of government research papers go unpublished, but the journal's many-month backlog indicates that very many such papers are lying in the editor's basket.

Furthermore, the rise of nuclear physics has created special needs and no journal has come into being to provide for them. For instance, as far as ONR and AEC are concerned, there is no "normal" publication channel for the hundreds of nuclear physicists working on their programs. If results in this field are published they add to the burden of the present physics journals.

Nuclear physicists have an alternative: they can and do publish in McGraw-Hill's semitechnical magazine *Nucleonics.* It provides only limited publishing facilities but it fills, in a marginal way, a need that commercial backing can fill where a less favorable financial position prevents the nonprofit Institute of Physics from attending adequately to many of the scientists it was founded to serve.

Biological sciences. The situation as regards publication in the biological sciences is at least as serious

as in physics. For one thing, the research men in the biological sciences have not been organized until very recently. The American Institute of Biological Sciences was started just a year ago to serve this important group of scientists, whereas the American Institute of Physics was founded in 1931.

This looseness of organization has led to confusion. A count made recently by the American Institute of Biological Sciences reveals that there are in existence some forty journals in this field, some with a circulation of only two hundred. To mention just a few, there are the *American Journal of Physiology, Journal of General Physiology, Plant Physiology, Ecology, Ecological Monographs, Phytopathology, Journal of Parasitology, American Biology Teacher, Journal of Bacteriology, Bacteriological Reviews,* the *Bryologist, American Journal of Botany, Copeia, Journal of Heredity, Growth, Transactions of American Entomological Society, Journal of Economic Entomology, Entomological News.*

It would be difficult indeed to establish which are the normal channels for publication here. Many of the journals seem to overlap in function and field covered. Many reach such a limited audience that it would seem they hardly justify their publication costs. It is little wonder that publishers of most journals in the biological sciences are worried.

And yet the biologists constitute a large group that must be served. Seventeen member and affiliated societies, comprising over 10,000 scientists, have joined the AIBS in its first year of existence. Ten thousand scientists have much to say and there should be organized channels through which they could speak. AIBS has already appointed a Committee on Publication Problems to study the question. Under the capable direction of A. J. Riker, University of Wisconsin, this committee is trying to come up with some publication answers for its colleagues.

Time for Government Action?

It is not necessary to recount here the publication troubles besetting scientists in other fields. It is safe to say that for the most part the learned journals are refusing good articles, forcing authors to pay for the privilege of publication, or reducing articles to little more than abstracts. To the extent that the scientific press has been forced to exclude useful material the progress of science is being slowed. To that extent, the normal channels, as the situation now stands, are proving inadequate to the dissemination of the nation's scientific information.

The scientific journals are not to blame for the situation and they can do little to correct it. But the government agencies that provide the principal support of research might logically be expected to help shoulder the burden of publication that this research creates.

The scientific information divisions of the government agencies are concerned with the problem. They have listened to various schemes and suggested various schemes. Many sent representatives to the Royal Society Scientific Information Conference mentioned before, which brought together heads of departments in universities and technical colleges, directors of government laboratories, research associations and industrial laboratories, and editors of scientific publications in Britain and the United States. The conference was called "to discover in what directions improved services can be provided for the promotion of science by assisting working scientists in the dissemination and assimilation of scientific information" (*6*).

The first proposals the conference considered were for a panacea—one solution for all the world's scientific publication woes. The most publicized scheme was that presented by J. D. Bernal of Birkbeck College, London, for replacing the present system of independent journals with a system for distributing individually printed papers through a central agency. "National Distributing Authorities" would be created, to receive papers and refer them to panels of appropriate scientific societies. On acceptance, papers would be printed by the National Distributing Authorities concerned and distributed according to a detailed scheme.

Dr. Bernal's plan aroused such a storm of protest that he finally withdrew his paper from the conference agenda in the interest of harmony. The official protest of the Society for Freedom of Science (Great Britain) contains the following statement (*4*):

> Scientific publication is a natural and indispensable sequel to scientific investigation, the two together forming an indivisible process which rests essentially on the individual freedom of men of science to work, write and publish as they choose within the powers they recognize as their own. The scheme for centralized printing and issue of scientific papers seems to threaten these rights to scientific freedom very directly and to involve a great over-all loss of efficiency.

In view of this violent reaction it would seem wise to recognize the fact that we cannot hope to solve our problem with any one scheme. If the experience of the conference is any criterion, many solutions must be sought and many experiments undertaken before we can approach effectiveness. The conference made progress only when it settled down to tackling the problem by many methods in many places. Delegates returned to their countries determined to clean out their own closets first.

Proposed Steps for Government Research Agencies

These are the steps proposed, then, for action by government research agencies (but no one of the steps is adequate alone):

1. *Support of the normal channels.* It must be recognized that the normal channels through which scientific information is published, if they are to cope with a billion dollars of research annually, must be supported.

Existing legislation of course prohibits a government agency from supporting a private publication. That regulation need not be challenged. Support could be given to the learned societies or to groups of learned societies through their institutes to set up a central clearing office to cope with the publication problems of their own official journals. The American Institute of Biological Sciences has such a central unit under consideration to help solve the publication problems of its members, and funds are being sought for support from private research foundations. It seems only fair and right that the government agencies sponsoring research should lend their support, too.

How would this central publications unit function? It could consolidate weak journals into one effective stronger journal. It could negotiate with a printer a joint contract for a number of the journals of its constituent societies and thus obtain better printing rates by standardizing the physical characteristics of the journals. Type, paper stock, format, and other physical factors could be standardized and yet each journal could retain its individuality by means of such details as cover page and text divisions. The American Institute of Physics has already established itself as such a clearinghouse, with some success, but perhaps it could be more successful with outside support.

2. *Intra-agency publication.* Each government agency should provide some medium within its organization for publication of its own research. The National Bureau of Standards seems to have set a pattern that works effectively. Its unclassified *Journal of Research* is recognized by its scientists as worthy of carrying their papers. The *Journal* occupies a dignified, honored place, along with other well-recognized scientific journals. Furthermore, full reports on work reviewed in the *Journal* are readily available from the Government Printing Office and are widely used by scientists requiring detailed data on a specific research problem.

Other government agencies could establish such declassified journals, which would achieve reputation quickly by virtue of the unchallenged reputation of the scientists who would publish in them.

The last war demonstrated how scientists rally to the national defense. The success of the government's postwar research program attests that they are still interested in contributing to the national security. Offering them opportunity to publish in government journals would be a way to make them feel more effective. One ONR contractor, James A. Reyniers, of the University of Notre Dame, expresses a scientist's feelings in this respect: "One of the mistakes that governmental supported research can make is to become a vast silent repository into which a scientist's best efforts can be dumped with no echo in return."

3. *Exploration of other mediums.* We must constantly be alert to other supplementary mediums for disseminating scientific information. For instance, the government must support on an increasing scale symposia in which experts in a given field are brought together from government, industrial, and academic laboratories to tell each other what they are doing. The Royal Society Scientific Information Conference records as a recommendation of one of its working parties that "reports on 'symposia' are recognized as a valuable contribution to the recording of progress in science."

The Committee on Technical Information of the Research and Development Board plans to explore other existing mediums that can be used more and to better purpose.

The problem of adequate scientific publication is urgent. If, as Steelman recommends, the nation doubles its present research budget by 1957 then it must also double its effort in publication. It is a problem everyone concerned with science must face. Surely the original and active minds of science can solve this problem, as they have solved so many greater problems in the past.

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TECHNICAL PAPERS

Cysteine Protection against X Irradiation

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It is generally considered that many of the biological effects of radiation can be attributed to the activated water reactions which result from the irradiation. Inhibition or inactivation of enzymes and other materials by the actions of the decomposition products of water (OH, H_2O_2, O_2H, H) and the prevention or reversal of these effects under certain conditions have been reported by a number of investigators. Barron (*1*) has found that sulfhydryl-containing enzymes are readily oxidized by radiation and that it is possible to reactivate such enzymes after moderate radiation doses (100–200 r) on addition of a reducing agent such as glutathione. Reducing amino acids, glutathione, and ascorbic acid have been reported by Ephrati (*2*) to protect tetanus toxin against the effects of X-rays, whereas oxidizing substances are without effect. The finding by Evans (*3*) that the toxicity of irradiated water to *Arbacia* sperm is reduced by catalase also supports the concept of indirect action by the decomposition products of water. Although other related observations are cited in the literature (*4*), the extent to which oxidizing and reducing substances contribute to radiation damage *in vivo* has received little, if any, consideration. We should like at this time to communicate some of our observations concerning the influence of cysteine, the amino acid-containing —SH, and cystine, its oxidized counterpart, on the radiosensitivity of rats.

Since, in our experience, the product (toxicity, survival time, hematologic change) of radiation dose rate times duration of exposure appears to be a constant over a fairly wide range, we have employed brief exposures to fairly intense radiation on the assumption that a potentially protective material should be present in the blood and body fluids in high titer during the entire exposure. The radiation factors were: 250 kv, 15 ma, 0.5-mm Cu and 3.0-mm Bakelite filters, 27.5 cm target distance, and 210 r/min dose rate. Male and female rats (Sprague-Dawley) weighing 150–250 g received 800 r total-body X radiation in a single exposure. Animals of the same sex were irradiated in pairs, one serving as a control, the other as a treated animal.

Cysteine was injected into a tail vein either 1 hr before, 5 min before, or 5 min after exposure. Neutralized (pH 7) as well as unneutralized (pH 1) cysteine-HCl solutions were compared. Four different doses were employed (175, 350, 575, and 875 mg as cysteine per kg body weight). A 20% cysteine-HCl solution was used to decrease the volume of injected fluid. Since rapid injection of this concentrated solution, especially with the higher doses, may result in acute pulmonary edema and death (also true with 20% NaCl), the cysteine was injected slowly over a period of several minutes. Occasional sloughing of the tail was seen at the injection site. It is of interest that this reaction can be prevented by anesthetizing the rat before injection. Cystine is relatively insoluble at pH 7, and only an acid solution of this material was used (6.66%, pH 1, 280 mg/kg body weight). Irradiated controls for the neutralized cysteine-HCl groups were injected intravenously with an equivalent volume of a 5% solution of NaCl. All other controls received I.V. injections of 0.9% NaCl adjusted to the pH of the test solutions. All rats were fed Derwood Checkers and water ad lib.

TABLE 1

EFFECT OF PRETREATMENT WITH CYSTEINE AND CYSTINE ON SURVIVAL AFTER TOTAL-BODY X IRRADIATION WITH 800 ROENTGENS*

Treatment group	Dose mg/kg	pH of injected material	Number of rats	% Survival after irradiation: 1st week	2nd week	3rd week	4th week	5th week
Control†			20	100	35	25	20	20
Cysteine	175		20	95	80	80	75	75
Control			22	86	32	27	27	27
Cysteine	350	1	19	100	95	89	89	89
Control			22	95	27	10	10	10
Cysteine	575		17	94	82	82	82	82
Control‡			14	57	7	7	7	7
Cysteine	350		15	100	87	47	47	47
Control			14	64	7	0	0	0
Cysteine	575	7	15	93	66	47	47	47
Control			27	70	19	7	7	7
Cysteine	875		25	92	92	84	80	80
Control†		1	27	52	22	15	15	15
Cystine	280		22	68	18	18	18	18

* All injections intravenously 5 min before irradiation.

† Controls received equivalent volume of 0.9% NaCl (pH 1) I.V.

‡ Controls received equivalent volume of 5% NaCl (pH 7) I.V.

Our findings reveal that pretreatment with cysteine markedly reduced toxicity from total-body X irradiation (82% survival, cysteine [pH 1] pretreated; 19% survival, irradiated controls). We have obtained similar results in mice (*5*). On the other hand, the disulfide, cystine, did not influence survival. Cysteine-HCl administered at pH 1 seemed equally effective at each dose level. However, with the neutralized preparation, greatest protection was afforded when the highest dose (875 mg) was

used. This may possibly be explained by the fairly rapid oxidation of cysteine to cystine in a neutral medium before its administration. A similar reduction in mortality was observed when cysteine was given either 5 min or 1 hr before X irradiation. Significantly, injection of cysteine immediately after the exposure was ineffectual.

TABLE 2

INFLUENCE OF TIME OF INJECTION OF CYSTEINE ON SURVIVAL AFTER X IRRADIATION WITH 800 ROENTGENS*

Treatment group	Time of injection relative to X irradiation	Number of rats	% Survival after irradiation			
			1st week	2nd week	3rd week	4th week
Control	5 min before	15	73	20	13	13
Cysteine	5 min before	15	87	87	87	87
Control	1 hr before	15	80	20	20	20
Cysteine	1 hr before	15	100	87	80	80
Control	5 min after	16	88	19	13	6
Cysteine	5 min after	15	60	20	13	13

* Cysteine—875 mg/kg I.V., pH 7; controls received equivalent volume of 5% NaCl I.V.

These results are summarized in Tables 1 and 2. If all rats receiving cysteine at either pH 1 or 7 before their irradiation are considered as a single group, there are 92 survivors of 126 cysteine-treated animals (73%) as compared with 18 survivors of 134 irradiated controls (13%). These findings are highly significant statistically ($p \ll .001$).

Change in body weight was followed in a small group of rats pretreated with cysteine. Body weight is a fair prognostic sign of ultimate toxicity in the irradiated rat. Although the initial decrease was similar in the cysteine-pretreated and in the control animals, body weight recovered rapidly in the former.

We may conclude that cysteine, but not cystine, administered to rats prior to X irradiation in the nearly completely lethal range, greatly diminishes toxicity. This ameliorating influence may reside in the protection afforded certain critical cellular constituents against oxidation by the presence of cysteine or an intermediate of cysteine. A study of the protective influence of cysteine when administered at longer intervals before irradiation and by different routes as well as of other substances, such as glutathione, methionine, tryptophane, and ascorbic acid, is in progress. The metabolism of injected cysteine in the irradiated animal and its effect on the hematologic and histologic changes induced by radiation will be reported in detail in a subsequent communication.

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Humidifying Apparatus for Small Test Rooms

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The wood-element hygrostat illustrated in Fig. 1 was devised by Torgeson for use in an experimental lumber dry kiln at the U. S. Forest Products Laboratory, Madison, Wisconsin. Because of its simplicity and sturdiness it later was installed in each of two 600-cu-ft rooms used at the laboratory for accelerated testing of the resistance of wood and wood products to decay by pure cultures of wood-destroying fungi. As set, the hygrostat, in conjunction with the humidifier illustrated in Fig. 2, maintains a relative humidity of 70% with deviations of about ±2%. The temperature of the rooms is thermostatically kept at 80° F. Over several years, no adjustment in setting on account of changes in characteristics of the hygrostat has been needed. The reliable performance and simplicity of this humidification system should make it useful in many connections requiring humidity control within a moderately narrow range and at a level greater than that prevailing outside the space to be conditioned. It is already being used for biological work at a number of other laboratories.

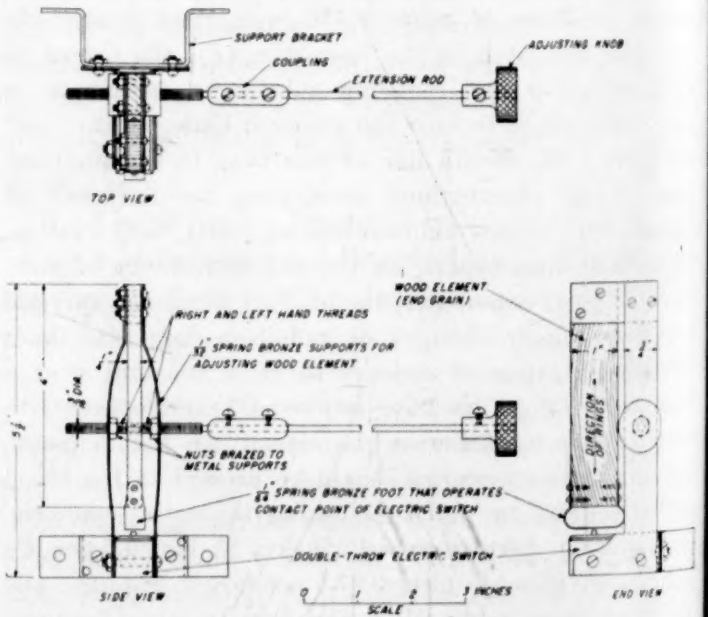

FIG. 1. Hygrostat.

The novel features of the hygrostat consist of the wood element and a microtype switch that is sensitive to a very slight movement of the element. The wood should be free of defects and have as flat a grain as possible, for the flatter the grain the greater will be the dimensional change lengthwise of the element with a given change in relative humidity, and thus a correspondingly greater operating sensitivity of the hygrostat will be provided. The sapwood of hardwood species, such as

maple and birch, makes a good element. The switch should be of the normally closed type. It is opened by pressure of the foot of the wood element against a protruding contact point, and this interrupts the flow of current through the heating coil of the humidifier. It is closed again and humidification is resumed as the element shrinks in response to decreasing relative humidity. No relay is required; the switch, which is designed for current loads up to 10 amps at 125 volts, is simply connected in series with the heating element of the humidifier.

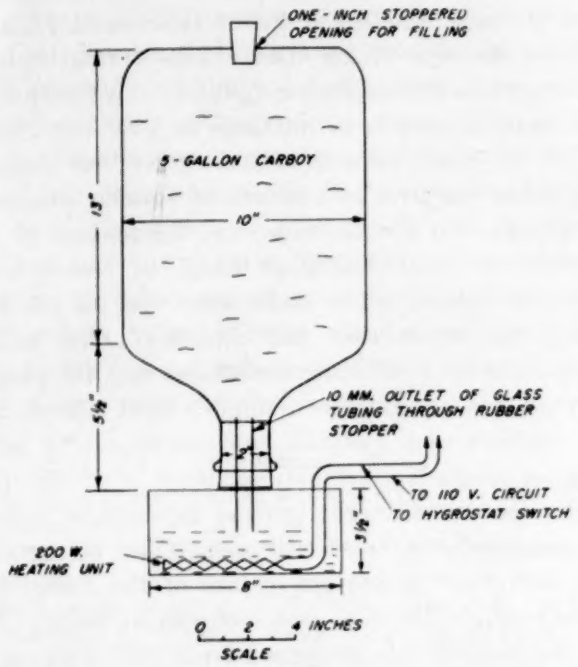

FIG. 2. Humidifier.

The relative humidity to be maintained is controlled by the proximity of the element foot to the switch contact point, which is regulated by adjusting the spacing between the spring bronze element supports. These supports are spread or contracted by turning the right- and left-hand threaded screw in the nuts brazed to the supports. The final adjustment is arrived at by trial and error, using a wet- and dry-bulb hygrometer to indicate when the proper setting has been made.

The humidifier (Fig. 2) consists of a closed 5-gal reservoir of water that feeds through 10-mm glass tubing into a glass evaporating pan. Heat is supplied by an open, 200-w heating coil submerged in the pan. A sealed heating unit probably would give longer service, although the open coil is remarkably durable when kept submerged. The smaller the heat output of the unit, the smaller will be the overrun in humidification resulting from lag in the response of the hygrostat.

The water reservoir is filled as necessary through a ½-in. hole bored in the top. A rubber stopper is inserted in the outlet tube during the filling process. Distilled water is used because of the extreme hardness of the tap water at Madison, although lime would not, of course, materially interfere with the operation of the apparatus if it were removed from the evaporating pan and heating unit frequently enough to prevent large accumulation.

Significant stratification of relative humidity and temperature in the controlled rooms at the laboratory is avoided by keeping an electric fan running at low speed in each room.

From measurements made in one of the rooms during the winter, it was found that about 873 g water/day was evaporated in maintaining the 70% relative humidity. The humidifier was in operation about 5.8 hr each day, which entailed a daily power consumption of about 1.16 kwhr. Corresponding summertime values were not measured, but are known to be considerably smaller. The room in this case is walled on three sides with double sheet rock panels with mineral wool insulation batting between them, and on the fourth side with unglazed tile. All conspicuous cracks and similar openings to the outside are sealed with calking compound, a measure that materially reduces the amount of humidification required.

To provide a relative humidity lower than that of the outside atmosphere, some arrangement for increasing the temperature (if this could be tolerated) or for dehumidification would, of course, be necessary. In any case, the wood-element hygrostat could be adapted to serve as the control apparatus.

Treatment of Nausea and Vomiting of Pregnancy with Dramamine—Preliminary Report

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Nausea occurs in approximately 50% of pregnancies, and in about 25% vomiting ensues. The severity of symptoms varies in individual patients. Frequently patients require hospitalization because of the excessive dehydration which occurs. However, in a study of 15,000 cases, Eastman and Hellman (*1*) have reported that in only one instance was interruption of the pregnancy necessary. The cause of these symptoms has never been definitely established.

Coincident with the study of the control of motion sickness with Dramamine (*2*), it was decided to investigate the effect of the drug on nausea and vomiting in pregnancy.[1] The following data are presented as a preliminary report of this investigation.

Forty-three women who had complained of these symptoms for 4–6 weeks had been given a number of remedies. Intravenous pyridoxine, oral pyridoxine, oral thiamine chloride, sedation, and psychotherapy had failed. Each patient was given 100 mg of Dramamine, three times daily. This dose was reduced to 50 mg three times daily for seven patients because of minor side-effects—drowsiness and vague subjective muscle tremors. Unknown to 10 patients, the drug was discontinued and a placebo of lactose, identical in appearance, was substituted.

Thirty-one patients (72.1%) of the 43 were completely relieved of their symptoms 3 hr after administration of Dramamine. Ten patients whose symptoms were con-

[1] Dramamine supplied by G. D. Searle & Co., Chicago.

trolled by the drug relapsed when a placebo was substituted, but immediately regained their normal health after Dramamine was again administered. Twelve patients (27.8%) of the 43 obtained no relief from the drug.

In summary, although the number of patients treated with Dramamine is small, the results are so encouraging that the Allergy Clinic and the Obstetrical Clinic of the Johns Hopkins Hospital and University are making an extensive comparative study. These data will be published in a subsequent report.

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Plasma and Liver Protein Levels in Rats Fed the Carcinogen 2-Acetylaminofluorene[1]

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Cook, Griffin, and Luck (*1*) have recently reported that azo dyes decrease plasma albumin and increase gamma globulin in rats. In addition, the carcinogenic activity of the drug can be correlated with the degree of change induced in these plasma components. The non-azo dye, 2-acetylaminofluorene (2AAF), however, failed to alter plasma protein levels after a 6-week feeding period, although its carcinogenic action is well known. Whether or not the drug would alter plasma protein levels when fed at different concentrations and for a longer time was considered of interest in elucidating this drug's actions.

The azo dyes induce liver tumors and have a definite effect on nucleic acid content of this organ (*2*, *3*, *6*, *7*). The non-azo dye 2AAF also causes formation of liver tumors and increases liver weight (*8*). We have extended these data to include estimations of liver water and protein in an effort to correlate the liver and plasma proteins, since the liver is a source of plasma albumin.

Forty-day-old female rats were maintained on Purina fox chow to which 0.03% or 0.15% of 2-acetylaminofluorene was added. The diets were fed ad lib. for 100 days, after which time the rats were bled by cardiac puncture under light ether anesthesia and the plasma was analyzed for nonprotein nitrogen, total plasma protein, and albumin and globulin concentrations by salt fractionation methods previously reported (*5*). The liver was dried to constant weight, ground to uniform consistency, and analyzed for total nitrogen. The nitrogen values were converted to protein by use of the factor 6.25.

Body weight increase was recorded at weekly intervals and the control rats increased from 100 to 237 g in 100 days. Body weight increase of rats fed 0.03% of 2AAF followed the controls for 11 weeks, starting at 102 g and increasing to 202 g, and then leveled off. The incorporation of 0.15% 2AAF in the diet resulted in an average body weight change from 90 to 164 g. These rats' weight at 6 weeks was constant for a 2-week period, then it increased slowly for 4 weeks but leveled off again. The results simulate those reported by Wilson *et al.* (*9*).

TABLE 1

PLASMA PROTEIN CONCENTRATIONS OF FEMALE RATS FED 2-ACETYLAMINOFLUORENE FOR 100 DAYS

Diet	No. of rats	Hematocrit %	NPN in mg%	Plasma proteins in g%*		
				total	albumin	globulin
Fox chow	6	40.4 ± 1.2	50 ± 3.0	4.99 ± 0.11	2.42 ± 0.06	2.57 ± 0.11
Fox chow + 0.03% drug	6	42.4 ± 1.2	51 ± 2.4	5.06 ± 0.14	2.52 ± 0.07	2.54 ± 0.18
Fox chow + 0.15% drug	5	40.4 ± 1.1	47 ± 2.0	4.64 ± 0.09	1.99 ± 0.13	2.65 ± 0.13

* $\varepsilon = \sqrt{\frac{\Sigma d^2}{N(N-1)}}$

TABLE 2

LIVER PROTEIN OF FEMALE RATS FED 2-ACETYLAMINOFLUORENE FOR 100 DAYS

Diet	No. of rats	Wt in g	H_2O %	Liver protein*		
				Dry wt %	Total g	Total g/100g BW
Fox chow	6	7.77 ± 0.4	70.1 ± 1.2	65.4 ± 0.8	1.43 ± 0.2	0.629 ± 0.015 (0.589 – 0.696)
Fox chow + 0.03% drug	7	8.08 ± 0.3	70.3 ± 0.3	60.8 ± 1.0	1.44 ± 0.04	0.710 ± 0.015 (0.665 – 0.791)
Fox chow + 0.15% drug	7	7.39 ± 0.4	70.3 ± 0.2	61.1 ± 1.9	1.36 ± 0.05	0.852 ± 0.024 (0.755 – 0.939)

* $\varepsilon = \sqrt{\frac{\Sigma d^2}{N(N-1)}}$

Table 1 shows the hematocrit, plasma nonprotein nitrogen, and plasma protein concentrations. Plasma albumin concentration was significantly subnormal in rats fed 0.015% of 2AAF, but other analyses were unchanged.

To determine whether liver size or protein content was

[1] Supported in part under a grant-in-aid from the American Cancer Society upon recommendation of the Committee on Growth of the National Research Council.

altered in rats exhibiting subnormal plasma albumin levels, these organs were analyzed for total protein, and the data are presented in Table 2. It is apparent that liver size and water content were unchanged by the drug, and despite a slight decrease in percentage of protein the total protein content of the liver was normal. Since the animals fed the drug lagged in growth rate the liver protein in relation to body weight was significantly increased and in proportion to the amount of drug fed. This is interesting, in that the slower growth rate with reduced food intake would seem more likely to be associated with a smaller liver. Reduction of food intake will rapidly decrease liver size and protein level (*4*). 2-Acetylaminofluorene can therefore significantly increase liver protein to body weight ratios without altering plasma protein concentrations, but a decrease in plasma albumin can be induced if drug concentration is high.

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Correlation of Browning, Fluorescence, and Amino Nitrogen Change with Destruction of Methionine by Autoclaving with Glucose[1]

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The destruction of lysine by autoclaving in the presence of glucose was demonstrated by Stevens and McGinnis (*8*). These workers observed that the autoclaved mixture of glucose and lysine was dark brown in color. Patton and Hill (*6*) reported that tryptophane, in a bacteriological culture medium containing glucose, was destroyed to a certain extent by autoclaving. This destruction was not observed when sucrose was substituted as a source of carbohydrate. Hsu, McGinnis, and Graham (*4*) found that methionine was destroyed or rendered unavailable to chicks by autoclaving in the presence of either glucose or lactose, and to a certain extent in the presence of sucrose. In contrast, methionine was unaffected by heating in the presence of starch or dextrin. Acid hydrolysis of the autoclaved mixture of glucose and methionine failed to liberate the amino acid for support of chick growth. They also found that autoclaving a soybean protein with glucose damaged the protein to the extent that supplementary methionine, lysine, and tryptophane failed to restore its nutritive value for chicks. These observations indicate that other amino acids, in addition to the three named, were destroyed or rendered unavailable. Evans and McGinnis (*2*) showed that cystine in soybean oil meal was destroyed during autoclaving. In contrast, the same autoclaving treatment failed to alter the methionine content. Patton, Hill, and Foreman (*7*) reported that lysine, arginine, tryptophane, and histidine were destroyed when an intact soybean protein was refluxed in a 5% glucose solution for 24 hr. In view of the results reported by Hsu, Graham, and McGinnis (*5*) showing that the concentration of amino acids or crude protein in an aqueous solution of glucose markedly influenced the amount of browning and destruction of amino acids, it should be pointed out that the concentration of protein used by Patton, Hill, and Foreman (*7*) was only 1%.

Chen, Medler, and Harte (*1*) found that highly fluorescent substances were formed from certain amino acids when they were heated with Denigès reagent (paraformaldehyde and sulfuric acid). A similar observation

TABLE 1

Correlation of Browning, Fluorescence, and Amino Nitrogen Change with Destruction of Methionine by Autoclaving with Glucose

Methionine mg/culture	Dry wt of mold in mg			Brown color: optical density at 380 mμ (×100)	Fluorescence equivalents: mg quinine sulfate/g methionine	α-Amino nitrogen: % of theoretical value
0.1*	11.1	11.1	11.1§	0	0	102.2
0.2	18.5	18.5	18.5			
0.4	32.0	34.4	33.2			
0.6	55.2	53.2	54.2			
0.8	64.9	61.9	63.4			
1.0	69.7	68.9	69.3			
0.1†	11.4	11.2	11.3	5.6	.965	93.7
0.2	18.3	18.3	18.3			
0.4	31.8	34.9	33.4			
0.6	50.2	52.4	51.3			
0.8	58.9	62.9	60.9			
1.0	67.0	63.1	65.1			
0.1‡	..	3.5	3.5	180	14.25	15.1
0.2	3.8	3.8	3.8			
0.4	5.8	5.8	5.8			
0.6	6.7	6.2	6.5			
0.8	8.2	8.2	8.2			
1.0	9.5	9.6	9.6			

* Methionine autoclaved alone for 2 hr at 120° C.

† Methionine (2 g) dissolved in 100 ml of 8% glucose solution and autoclaved 2 hr at 120° C.

‡ Methionine (2 g) mixed with glucose (8 g) and autoclaved 2 hr at 120° C.

§ Average of duplicates.

[1] Published as Scientific Paper No. 829, Washington Agricultural Experiment Station, Institute of Agricultural Sciences, State College of Washington, Pullman.

[2] Now at Department of National Health and Pensions, Ottawa, Ontario, Canada.

had previously been made in this laboratory when glucose was used to furnish the aldehyde group instead of Denigès reagent. All of the amino acids tested (approximately 15) formed fluorescing substances when mixed with glucose and autoclaved at 125° C for 1 hr.

The experiments described in this paper were conducted to determine whether a relationship exists between the degree of browning, the production of fluorescing substances, changes in amino nitrogen, and the ability of methionine autoclaved in the presence and absence of glucose to support growth of a methionineless mutant of *Neurospora crassa* No. 38706.

The methionine used in these experiments was treated as indicated in footnotes to Table 1. These differently treated samples of methionine were appropriately diluted for the determination of optical density or brown color concentration, fluorescence, amino nitrogen, and methionine content as evidenced by the ability of the material to support growth of *Neurospora crassa* No. 38706.[3] The results obtained are summarized in Table 1. From these data, it is evident that brown color formation, fluorescence, and decreased amino nitrogen are associated with destruction of methionine brought about by autoclaving in the presence of glucose, but in the absence of an excessive amount of water. Under the experimental conditions in this laboratory, autoclaving methionine in an 8% solution of glucose failed to bring about any marked destruction or changes in brown color, fluorescence, and amino nitrogen.

The data clearly show the important influence of water on the destruction of methionine autoclaved in the presence of glucose, on the loss of amino nitrogen, and on the formation of brown color and fluorescing substances.

[3] Samples were diluted in 0.1 M phosphate solution pH 4.8. Fluorescence was determined in the Coleman Photofluorometer, using the B_1 filter. The instrument was standardized at 100 with quinine sulfate solution (0.1 mg/l 0.1 N H_2SO_4). Brown color was measured as optical density of the phosphate solution at 380 mμ in the Coleman Universal Spectrophotometer. Amino nitrogen was determined by the method of Van Slyke (*9*). The methionine assay was conducted as outlined by Horowitz (*3*).

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Comments and Communications

Characteristics of Some Disease-free Ornamental Plants

Modern medicine has learned that people in good health are worth study. It may be hoped, then, that plant pathologists will learn to give special consideration to those plants which have few diseases or pests. As a step in this direction, information has been assembled in this paper regarding a considerable group of ornamental plants in which, in the eastern United States at least, no important diseases or pests are known.

Dodge and Rickett include in *Diseases and pests of ornamental plants* (1943) the names of approximately 75 plants which are practically disease-free. This is almost unique in such a book. In the introduction, the scope and purpose of the authors are carefully defined. "We have tried to select those [diseases and pests] which have been most injurious in the eastern United States; most of these are also the most troublesome in other parts of the country and of the world. . . . Our selection of cultivated plants is based upon the 3,000 species and varieties grown at the New York Botanical Garden." The book thus serves admirably as a check list of diseases and insect pests of ornamental plants in the northeastern United States; over 500 genera are included.

In studying 75 disease-free plants, answers to three questions were sought. What are their characteristics? What, if any, characteristics do they have in common? Is it possible that these common characteristics have any bearing on their disease-free status in the eastern United States? (Much of the work of compiling the information on which this paper is based was done by members of a class in the epidemiology of plant diseases.)

The plants are not taxonomically related. They are scattered through 38 families; the largest number in any one family being nine in the Compositae. They show diverse growth habits. There is one tree (Ginkgo), one woody vine (Wisteria), eight shrubs, and the rest are herbs. The plants which have no important diseases or insect pests are predominantly seed-propagated and are either annuals or very short-lived. Only one is reproduced by bulbs, 17 are reproduced chiefly by division; the rest either may be, or must be, grown from seed.

They are also predominantly of foreign origin. Only 15 (20%) seem to be natives of the continental United States. Eurasia has furnished 33; others come from Africa, Australia, South America, and various tropical localities. An introduced plant (all but 15 of these 75 plants were introduced into the United States) which has

been brought in as seed may well have left its native parasites behind, to its own great advantage. (Bailey, L. H. *Trans. Ind. Hort. Soc.*, 1892, p. 62. See also *The survival of the unlike*, 2nd Ed. New York: Macmillan, 1897, p. 180. Stevens, N. E. *J. Amer. Soc. Agron.* and several papers cited therein, 1948, 40, 841). Many of these plants have no near relatives in the region. Actually more than half (43) of the genera are not mentioned in standard floras of the northeastern United States as either native or established. Finally, all are of minor commercial importance. Many are actually rare: their names are listed in catalogs of dealers in rare seeds. None of them is found growing in large acreages. Indeed, among them are many plants used in rock gardens and borders.

A study of these facts leads to the conclusion that many of these plants may well be escaping disease and insect pests because of the way in which they are now grown, rather than because they are actually immune or even resistant. The very fact that these plants are of minor commercial importance and are usually grown in very small groups is a great safeguard. A mutant strain of a fungus, for example, which was seriously pathogenic on a plant or clump of Anoda, an annual so rare as not to be mentioned in Bailey's *Cyclopedia of horticulture*, might well kill its available hosts, produce spores, and itself die out without any viable spores ever reaching another plant of Anoda. Nowhere would a new mutant fungus find large areas of any of these plants on which it might produce the abundant inoculum so essential to the initiation of a great epidemic. Many of these plants are further isolated because they are predominantly grown in cities.

The circumstance that many of these plants have no near relatives among wild plants of the region affords further protection. It is undoubtedly true that some pathogens, particularly some viruses, and such fungi as *Botrytis cinerea* have a wide range among unrelated green plants. It is also true that serious diseases or insect pests of cultivated plants are more likely to come from closely related plants. Slightly more than 100 genera were reported as having no fungi of importance, and the average number of insects was less than one (0.4). On more than 100 genera only one fungus of importance was reported, and there was an average of less than one insect per genus (0.7). Almost 100 genera had two important fungus pathogens, and the average number of insects was almost exactly one. In two groups of 54 genera, 3 and 4 fungi respectively were reported, while the average numbers of insects for these categories were 1 and 2. On only 23 genera were there 5 important fungus pathogens reported and these had an average of 3 insect pests. The 15 genera which had 6 fungi had an average of 3.5 insect pests. On the small groups having 7, 8, and 9 fungi, the average numbers of insects found were 6.0, 7.2, and 6.8 respectively. For the few genera of ornamental plants which had from 10 to 20 fungi, the number of insects ranged from 6 to 13. This gives a correlation of 0.8–0.06. It seems probable that the same qualities in a host which favor parasitism by various fungi also favor parasitism by various insects.

Since the number of insects jumped rather sharply in the group of hosts with 7 important fungi, those plants which had 7 or more fungus pathogens with an average of 6 or more insect pests were classed together as a group in which pathogens might well be considered important. Exactly 40 genera were found to belong in this class.

In one respect only do the ornamental plants on which occur numerous pathogens resemble the disease-free group with which they are here being compared. These plants also are widely scattered taxonomically. Twenty-eight plant families are represented; the largest number of genera in a single family being four each in the Ranunculaceae and Compositae.

In this group also there is a diversity of growth habits, but with a decided difference in distribution. Nine genera, almost one-fourth, are trees as against one in the disease-free group. Shade trees are in general exposed to attacks of fungi and insects more than most ornamental plants, since they remain for many years in one place. Many are very large and receive only a minimum of protective treatments. Woody vines are represented by one genus or two closely related genera. Five genera are wholly or chiefly shrubs and the rest are herbs.

Vegetative reproduction is relatively much more common in this group. Of the 31 herbaceous genera, 7 are propagated by bulbs, and 8 more by rooted cuttings, division, or other vegetative means, the rest by seeds.

Again in contrast to the disease-free group, of which only 15 (20%) appear to be native to the continental United States, 24 or well over half of the genera with many diseases and pests, are native, and 5 more are well established in the area we are considering. The imported plants come from Eurasia, the Orient, the Mediterranean region, the tropics, and South Africa.

The greatest contrast between these two groups, however, is in the abundance—that is, number of individual plants—in most of the genera represented in this disease-susceptible group. Such trees as elm and oak, for example, are among our commonest shade and forest trees. Greater abundance resulting from intensive cultivation is clearly indicated by the commercial importance of many of the shrubby and herbaceous genera.

Stated in another way the material summarized in this communication emphasizes the disease hazards resulting from growing perennial plants as compared to annuals, and from growing large concentrated masses of the same kind of plant—especially if vegetatively propagated. These hazards are of course characteristic of much of present day fruit culture and floriculture. In raising rare, imported plants, these hazards are avoided, especially when plants are grown from seed.

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Association Affairs

Headquarters hotels for the 116th Meeting of the AAAS in New York City, December 26–31 are as follows:

Statler: AAAS, Annual Science Exposition, Science Theatre, Visible Directory; Sections B, C, F, M, Nm, Nd, Np; zoological societies, *viz.*, American Society of Parasitologists, American Society of Zoologists, Society of Systematic Zoology, American Society of Protozoologists; American Microscopical Society, American Society of Naturalists; American Institute of Electrical Engineers, Instrument Society of America, Technical Society Council of New York, Metropolitan Section of Mechanical Engineers; American Dietetic Association; Beta Beta Beta, Phi Lambda Upsilon, Sigma Delta Epsilon, and Sigma Xi.

New Yorker: Sections E, H, I, L, Q; Geological Society of America, American Geographical Society of New York, Association of American Geographers; AAAS Cooperative Committee; the Science teaching societies, *viz.*, American Nature Study Society, National Association of Biology Teachers, National Science Teachers Association; Society for Research in Child Development; American Sociological Society, Rural Sociological Society; Philosophy of Science Association, American Philosophical Association.

McAlpin: Sections G, O; the plant science societies, *viz.*, American Society of Plant Physiologists, American Society of Plant Taxonomists, Botanical Society of America, Mycological Society of America, Torrey Botanical Club, American Fern Society, American Bryological Society, Phycological Society of America.

Martinique: American Phytopathological Society.

Governor Clinton: Sections A, D, K; American Mathematical Society, Institute of Mathematical Statistics, Mathematical Association of America; American Society of Limnology and Oceanography, Biometric Society, Ecological Society of America, Genetics Society of America, American Society of Human Genetics, Society for the Study of Evolution; Academy of World Economics; Alpha Epsilon Delta; Phi Kappa Phi; Pi Gamma Mu; Metric Association.

Coupons for advance registration and hotel reservations will be found on pages **viii** and **ix**, respectively, of this issue.

Five AAAS-sponsored symposia are being planned. While others may be announced at a later date, those definitely scheduled are:

Science in General Education (at all levels). Earl McGrath, Commissioner of Education of the U. S. Office of Education, Morris Meister, principal of the High School of Science, New York City, and Paul B. Sears, chairman of the Department of Botany, Oberlin College, will discuss problems of science in general education, the importance of biological sciences, and the understanding of science for all populations. General secretary Karl Lark-Horovitz is in charge.

The Improvement of Science Teaching **on the College Level.** James B. Conant, president of Harvard University, Alan Gregg, director of medical sciences of Rockefeller Foundation, W. F. Loehwing, head of the Department of Botany, State University of Iowa, and Fernandus Payne, dean of the Graduate School, Indiana University, will each present a different aspect. President Elvin C. Stakman is in charge.

Both symposia will be held on Thursday afternoon, December 29, in the Statler's Grand Ballroom.

The Present State of Physics (Section B). Four sessions will cover elementary particles, chemical physics, physics of the solid state, and biophysics. The symposium is being arranged by F. S. Brackett, chief, Low Energy Radiation Biology Section, Experimental Biology and Medicine Institute, National Institutes of Health, Bethesda, Maryland. All sessions will be held in the Georgian Room of the Hotel Statler. Session 1—Thursday afternoon, December 29; Session 2—Friday morning; Sessions 3 and 4, consecutively—Friday afternoon, December 30. A symposium volume is contemplated.

Steroid Hormones and Sex Differentiation in Vertebrates (Section F and American Society of Zoologists). Several speakers will discuss this subject in the principal vertebrate classes. The symposium is being arranged by Section F Secretary J. H. Bodine of State University of Iowa, and L. V. Domm, Department of Anatomy, University of Chicago. The session will be held in the Grand Ballroom of the Hotel Statler on Friday afternoon, December 30.

Botany in the Service of Mankind (Section G). Four members of this panel have already accepted. Frans Verdoorn, of *Chronica Botanica*, will discuss "International Organizations and Activities," Knowles A. Ryerson, dean of the College of Agriculture of the University of California, "Botany and Point Four [of President Truman's Inaugural address]," and S. T. Dana, dean of the School of Forestry and Conservation of the University of Michigan, "Botany in the Service of National and World Forestry"; Gove Hambidge, special assistant to the director, Food and Agriculture Organization of the United Nations, "Botany in the Service of National and World Agriculture," and a fifth speaker will take "Botany in the Service of National and World Health." W. C. Steere, chairman of Section G, and chairman, Department of Botany, University of Michigan, will act as moderator. Section Secretary, Stanley A. Cain, Cranbrook Institute of Science, is arranging the program. The session will be held Thursday afternoon, December 29 in the Winter Garden of the Hotel Statler.

An atomic energy demonstration and lecture by J. R. Dunning of Columbia University, sponsored by Sigma Xi, is scheduled for Monday evening, December 26, in the Grand Ballroom of the Hotel Statler. The Annual Address of this society will be given Tuesday evening, December 27.

NEWS and Notes

A Presidential Commission on Science and National Security was recently proposed by the Federation of American Scientists in a letter cosigned by 145 prominent scientists and sent to the President July 8. Initial reaction from the White House indicates that even wider sponsorship will be required if the proposal is to be given favorable consideration. The text of the letter is reproduced here:

"The current controversy over the Atomic Energy Commission has once again focused attention on the problem of security in relation to scientific discovery. We are deeply disturbed by the misconceptions which have been voiced recently on this subject, and by some measures which have been proposed for the prevention of espionage directed at our atomic weapons. We fear that in the heat of controversy important values are being overlooked and may be carelessly sacrificed.

"The dilemma of secrecy vs. long-range security has plagued us since the end of the war. The demonstration of the potency of science as a military adjunct, so dramatically and horrifyingly driven home at Hiroshima, has led to two almost universally accepted conclusions—first, intensive cultivation of science is essential to national security; second, since scientific knowledge, of certain kinds and in certain circumstances, may have great military significance there are advantages in withholding it from potential enemies. We are slowly becoming aware, as a nation, that ill-considered implementation of these two conclusions can lead to very serious conflicts. For the narrowest interpretation of military security demands that we reveal nothing that might conceivably be useful to a potential enemy, and that the information of possible military significance available to any individual scientist be kept at a minimum. On the other hand, the experience of science is that the withholding of knowledge, or the abridgment of freedom of thought, is a deadly contamination which very rapidly inhibits research. How are we to reconcile these two apparently conflicting requirements? How can we safeguard in *existing* knowledge what is essential to military security, without so debilitating science as to sacrifice the hope of obtaining *additional* knowledge?

"You yourself, Mr. President, pointed out the importance of scientific progress to the national welfare, and the grave danger to science of the continuance of an atmosphere of suspicion and distrust. For five years we have been trying to balance the legitimate security needs of the nation against the equally insistent needs of free scientific inquiry. Largely this has been done by improvisation in individual instances with little attempt to develop or follow a comprehensive national policy. Security decisions have been left to individual government agencies, often subject to various uninformed pressures. Without benefit of full discussion of the issues, public understanding has remained at a low level and, in consequence, public opinion has drifted perilously close to hysterical insistence upon secrecy at whatever cost. The situation has become so threatening, not only to scientific progress but to traditional American political freedom, that we feel that only through action on your part can the problem be brought under control.

"Therefore, we respectfully urge that you appoint, at your earliest convenience, a Special Commission on Science and National Security. We urge that this Commission be composed of foremost scientists and educators, outstanding men of public affairs, and representatives of Congress, the National Military Establishment, and other agencies of the Executive Branch. We urge that this Commission make a full investigation of the entire problem of security requirements in relation to the requirements for maximum development of science. We believe that the Commission should study, among others, the following questions:

1. What are the limits where excessive attempts at secrecy diminish instead of preserve our national security?
2. What are the areas of science to which security measures can and should be applied?
3. What classification procedures give maximum protection of information of military value with minimum restriction of exchange of information of purely scientific value?
4. To what extent, and under what conditions, should classified research be conducted outside of military laboratories?
5. What types of clearance procedures are effective, and admissible within the bounds of scientific and democratic tradition, in military laboratories, in non-military governmental laboratories, in non-governmental laboratories?
6. What would be the effect on the morale of scientists and on our total scientific program of applying political tests for participation in non-secret scientific work through requirement of (1) oaths and affidavits, or (2) investigation and clearance?
7. What have been the effects of present security measures and procedures on our scientific research programs, particularly in government?

"We believe that the Commission should study these matters, not only with the objective of reporting to you its conclusions and recommendations, but with the thought as well of providing a factual background on security procedures now in use, specific studies of the effects and effectiveness of these procedures, ways in which similar problems are handled in other countries, etc. We have been too long security-conscious with insufficient security education.

"American scientists differ in no way from their fellow-citizens in their desire to protect the best interests of their country. They seek no special dispensations or privileges. In opposing extreme advocates of military security they are really seeking not less security, but more. Our real strength lies not in the guarded knowledge of the moment, but in

our ability to keep in the forefront of advancing knowledge. We recognize that the issue of security vs. freedom of science is one of public policy and that opinions other than those of scientists must enter into its resolution. It is for this reason, and because we are convinced that the matter is of urgent importance, that we ask for the establishment now of a Special Presidential Commission of broad representation and scope.''

About People

Hans Staub, professor of physics at Stanford University, has been appointed professor of physics and director of the Institute of Physics at the University of Zurich. Dr. Staub, a native of Switzerland, has been at Stanford since 1938.

Robert C. Parkin, member of the staff of the Council on Medical Education of the American Medical Association, has been appointed assistant professor of clinical medicine and coordinator of postgraduate medical education at the University of Wisconsin Medical School.

W. D. Graham, assistant biochemist in the Division of Poultry Husbandry, Washington State College Agricultural Experiment Station, has joined the staff of the Department of National Health and Pensions, Ottawa, where he will conduct research in antibiotics.

Leslie J. Todd, of the Department of Chemistry at the University of Indiana, has been appointed associate professor of chemistry at Kent State University, Kent, Ohio.

Robert H. W. Strang, consulting oral surgeon and lecturer in orthodontia at Columbia and Temple Universities, has been appointed director of the newly founded Fones School of Dental Hygiene at the University of Bridgeport in Connecticut. The Connecticut State Dental Association recently gave Dr. Strang its Alfred C. Fones medal for his service to the dental profession.

Archie D. Hess, for several years chief biologist of the Health and Safety Department of the Tennessee Valley Authority, and former director of Malaria Control Research, has accepted a commission as scientist in the Reserve Corps of the Public Health Service and has been assigned to the Technical Development Division of the Communicable Disease Center at Savannah, Georgia, as an assistant chief of the division.

A. P. Elkin, professor of anthropology at the University of Sydney, will conduct a review of accomplishments in social anthropology in Papau and Melanesia for the South Pacific Commission. Dr. Elkin will make recommendations on what still needs to be done and assess priorities for further work in the field.

Joseph P. LaRocca, pharmacist at the Naval Research Laboratory, Washington, has been appointed professor of pharmacy at the University of Georgia.

Visitors to U. S.

E. Navajas, entomologist of the Instituto Biologico, São Paulo, Brazil, recently visited entomologists and others in the Smithsonian Institution and the Department of Agriculture.

Walter A. Saborido, president of the Argentine Medical Association and professor of gynecology at the University of Buenos Aires Medical School, recently visited the University of Texas Medical Branch, Galveston, to confer with Willard Cooke, professor of obstetrics and gynecology, and W. W. Nowinski, associate professor of neurochemistry.

Hilda Levi, of the Bohr Institute and the Zoophysiological Laboratory of the University of Copenhagen, is spending six weeks studying autoradiography at the Department of Radiation Biology, University of Rochester School of Medicine and Dentistry. Dr. Levi's study is supported by the Danish Rask-Örsted Foundation and the Rockefeller Foundation. She plans to teach autoradiography in a course on isotope tracers this year at the University of Copenhagen.

Recent visitors who conferred with scientists at the National Bureau of Standards included: **Domingo Albano** of the Argentine Airlines; **Palle Birkelund,** assistant librarian, University Library, Copenhagen, Denmark; **J. Cornelius,** production superintendent, and **A. R. Sloman,** research manager, Associated Pulp and Paper Mills, Ltd., Burnie, Tasmania; **C. C. Gotleib,** of the Computation Centre, McLennan Laboratory, University of Toronto, Canada; **J. N. Mitchell,** professor at the University of Bristol, England; **J. R. H. van Nouhuys,** director of the Fibre Research Institute, T.N.Q., Delft, Holland; **J. V. Rao,** engineer at the Public Works Department, Madras, India; **N. S. R. Sastry,** member of the Reserve Bank of India, Bombay; and **John Shone,** member of the London Blood Supply Depot, New Barrett, Herts, England.

Grants and Awards

The University of Illinois College of Medicine has received $15,000 from the U. S. Public Health Service for a study of the effects of the betatron X-ray beam on bone and cartilage. Research will be directed by Roger A. Harvey, of the Department of Radiology, and G. A. Bennett, of the Department of Pathology.

Philip S. Hench and E. C. Kendall, of the Mayo Clinic, Rochester, Minnesota, will receive jointly a **Lasker Award for Administrative and Scientific Achievement** in recognition of their recent studies in arthritis. The $1,000 award will be presented at the 77th Annual Meeting of the American Public Health Association in New York City on October 25.

The Paul-Lewis Laboratories Award in Enzyme Chemistry will be presented to Henry A. Lardy, associate professor of biochemistry at the University of Wisconsin, at the American Chemical Society's Atlantic City meeting in September. Dr. Lardy is receiving the $1,000 award for his recent research on biotin. The society will also honor Agnes Fay Morgan, chairman of the Department of Home Economics at the University of California, who will receive the **Francis P. Garvan Medal** for her studies in nutrition and dietetics.

Meetings and Elections

A Committee on Calorie Requirements, called by the Nutrition Division of the Food and Agriculture Organization of the United Nations (director: W. R. Akroyd), will meet in Washington, D. C., September 12. The committee will consider proposals of the secretariat and members aimed at defining scales of calorie allowances applicable to widely different types of population and conditions. Members of the committee are E. J. Bigwood, professor of biochemistry and nutrition, University of Brussels, Belgium; Ancel Keys, director, Laboratory of Physiological Hygiene, University of Minnesota; R. E. Johnson, until recently director, U. S. Army Medical Nutrition Laboratory, now professor of physiology, University of Illinois; Isabella Leitch, director, Commonwealth Bureau of Animal Nutrition, Rowett Research Institute, Bucksburn, Aberdeenshire, Scotland; Josué de Castro, director, Nutrition Institute, Rio de Janeiro, Brazil; Emile F. Terroine, director of the National Center of Study and Research on Alimentation and Nutrition, Paris, France; Hsien Wu, professor of biochemistry, Berkeley, California; and A. G. van Veen, professor of biochemistry, Biochemical Laboratory, Technische Hoogeschool, Delft, Holland. F. W. Clements, former director, Institute of Anatomy, Canberra, Australia, now head of the WHO Nutrition Section, will also attend the meeting. Jean Mayer of the FAO Nutrition Division will act as technical secretary.

A symposium on brucellosis will be held September 22–23 at the National Institutes of Health, Bethesda, Maryland. The veterinary, public health, clinical, bacteriological, and control aspects of the disease will be discussed. All sessions will meet in Wilson Hall, Administration Building. The symposium is being sponsored by the Bureau of Animal Industry, the National Research Council, and the National Institutes of Health (see *Science*, July 8, p. 56). Inquiries should be addressed to Dr. James T. Culbertson, Executive Secretary, Microbiology and Immuniology Study Section, National Institutes of Health.

The 1949 Conference on Instruments and Measurements and the **International Instruments and Measurements Exhibition,** sponsored by the Royal Swedish Academy on Engineering Sciences and the Association of Technical Physicists of Sweden, will take place in Stockholm September 21–24 and September 22–October 2, respectively. The conference has been arranged in four principal sessions: physical methods in chemical analysis and structure analysis; industrial control (methods); miscellaneous methods of measurements; and apparatus and instruments. Papers are invited and abstracts should be submitted before *September 1* to Y. Axner, Secretary, Kungl. Tekniska Högskolan, Stockholm 26, Sweden. Completed papers must be received by *September 24.* Hotel reservations should be made as soon as possible by letter to Hoteyllbyran, S:t Eriks-Mässan, Stockholm 5.

AEC News

A three-man temporary advisory committee has been set up to recommend ways to establish continuing cooperation between the electric power industry and the AEC. The committee plans to conduct a first-hand study of the commission's reactor program with a view to identifying potential areas of mutual interest to the power industry and the commission and make recommendations for bringing about a continuing program of cooperation in these areas. Committee members are Philip Sporn, president of the American Gas and Electric Company, chairman; Edward W. Morehouse, vice president of the General Public Utilities Corporation in New York; and Walton Seymour, director of the Division of Power in the Secretary's Office, Department of the Interior. It is expected that the survey will be completed and recommendations submitted by March 31, 1950.

On August 2, the third anniversary of the distribution program of radioactive isotopes for use as tracer atoms by U. S. researchers, the **Isotopes Division** announced that a total of 7,613 shipments had been made, for use in science, agriculture, medicine, and industry. Of this total, 7,025 have gone to research laboratories and hospitals in the U. S. Since September 1947, when foreign distribution was announced, 588 shipments, mainly for use in medical and biological studies, have gone to researchers in Argentina, Australia, Belgium, Brazil, Canada, Colombia, Denmark, Finland, France, Iceland, Italy, Netherlands, New Zealand, Norway, Peru, Spain, Sweden, Switzerland, Turkey, Union of South Africa, and the United Kingdom. Countries which are qualified to receive shipments but have not yet instituted orders are Chile, Cuba, Guatemala, India, Ireland, Lebanon, Mexico, and Uruguay.

In response to recommendations of its **Industrial Advisory Group,** the AEC is testing the possibility of selecting, screening, and declassifying information useful to industry without revealing its specific relevance to the atomic energy program. An advisory committee, representing professional societies and the business press, has been appointed and it in turn will recommend members for a small group of workers in the field of metallurgy who, after being cleared, will examine metallurgical information which may be declassifiable. This group will make recommendations of information that might be particularly useful to American industry and any of this information the AEC may declassify will be made available for publication to established metallurgical journals. If the metallurgy program proves effective the procedure may be extended to other fields of technology.

Oak Ridge National Laboratory has developed a relatively inexpensive radioantimony-beryllium neutron source which is now available for U. S. distribution as allocated through the AEC Isotopes Division.

The sources use a core of 32 grams of antimony metal surrounded by a $\frac{3}{16}$-in.-thick beryllium metal cup, the assembly being enclosed in an aluminum jacket. The entire unit is placed in the pile and the antimony activated to the desired level. It has been found that the saturated source will emit a total of about 8

million neutrons per second. A customer will have to make arrangements beforehand to provide a suitable storage space for the source; a lead pig with walls 4 in. thick would probably be sufficient.

Deaths

Neil E. Stevens, 62, professor of botany of the University of Illinois, died June 26 at his home in Urbana. Dr. Stevens was an authority on diseases of small fruits and the distribution of plant diseases, and contributed the comment on disease-free ornamental plants on page 218 of this issue.

Andrey Avinoff, 65, Russian-born entomologist, died July 16 in Doctors Hospital, New York City. Before he left Russia, Dr. Avinoff had made a collection of 80,000 butterflies, which are now in the Leningrad Zoological Museum. He served as director of the Carnegie Museum in Pittsburgh from 1926 to 1945, when he retired as director emeritus.

Roland G. D. Richardson, 71, mathematician and dean emeritus of the Brown University Graduate School, died at his home in Nova Scotia on July 17. Dr. Richardson retired in 1948 after 41 years at Brown. He was secretary of the International Congress of Mathematicians, which will hold its first session in this country next year.

Pedro N. Ortiz, 62, died August 4 at Mount Sinai Hospital, New York City, where he had been senior assistant clinician and advisor on tropical diseases for 12 years. Dr. Ortiz was former Commissioner of Health of Puerto Rico and during his administration established a Bureau of Uncinariasis to carry on the work of prevention and treatment of hookworm begun by Bailey K. Ashford of the U. S. Army Medical Corps.

José Kabigting Santos, 60, retired professor of botany, University of the Philippines, died August 6, at the Quezon Institute, Quezon City, Philippines, following a long illness. Dr. Santos was one of the pioneers in investigating sex inheritance in plants. He was the first president of the Philippine Scientific Society.

Recently Received—

International Conference on the Physics of Metals. (Sponsored by the International Union of Pure and Applied Physics and Netherlands Physical Society. Held in Amsterdam, 12–17 July 1948.) Published by Martinus Nijhoff, The Hague, Netherlands.

Problems of Early Infancy: Transactions of the Second Conference, March 1–2, 1948, New York City. Milton J. E. Senn, (ed.). Available from the Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21, N. Y. at $1.00.

Speciation in Salamanders of the Plethodontid Genus Ensatina by Robert C. Stebbins. (Univ. California Publs. in Zoology, Vol. 48, No. 6.) University of California Press, Berkeley and Los Angeles, California. $2.50.

Cultural Relations between the United States and the Soviet Union: Efforts to Establish Cultural-Scientific Exchange Blocked by U.S.S.R. (Dept. of State publ. 3480.) Supt. of Documents, U. S. Govt. Prntng. Office, Washington 25, D. C. Price 10¢.

Law and Government of the Grand River Iroquois by John Noon. (Publ. 12.) The Viking Fund, Inc., 14 East 71st Street, New York 21, N. Y. $2.00.

Fatty Acid Antibacterials from Plants by H. A. Spoehr *et al.* (Publ. 586.) Carnegie Institution of Washington, Washington 5, D. C. 50 cents paper, 75 cents cloth.

The Sixth Semiannual Report of the U. S. Atomic Energy Commission, submitted to Congress July 30, is a 203-page summary of the major developments in all phases of the AEC program. Weapons continue to be the central project, and increasing attention is being given to reactor development. But reports on programs in biology and medicine are broader than the others because much of the information in these fields is unrestricted. There are, for example, sections on acute radiation illness and burns, radiation and heredity, medical effects of the explosions over Hiroshima and Nagasaki, radioactive wastes, cancer research, and radiation and agriculture. The report is available under the title *Atomic energy and the life sciences,* from the Government Printing Office for 45 cents.

The Health and Safety Division of the U. S. Bureau of Mines has established a roof control section in an effort to overcome the hazards of falling rock and coal, which kill six times as many miners as explosions do. Headed by Edward M. Thomas, mining engineer, the new section will also study the adaptation of suspension roof support to more general use in mining and will provide consultation services to mine operators.

The Royal Society Scientific Conference: Report and Papers Submitted, PB 98072, a 723-page review of the problems involved in the publication of research, is available at $6.00. Sections of the report are devoted to publication and distribution of reports of original work; abstracting services; indexing and other library functions; and the preparation of reviews, annual reports, and related documents. ***A List of Periodicals and Bulletins Containing Abstracts Published in Great Britain,*** PB 98072-S, has also been prepared by the society's Abstracting Services Consultative Committee, and is available at 80 cents. Both reports may be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Checks should be made payable to the Treasurer of the United States.

Make Plans for—

Meteoritical Society, 12th annual meeting, September 6–7, University of Southern California, Los Angeles.

American Congress of Physical Medicine, September 6–10, Netherlands Plaza Hotel, Cincinnati, Ohio.

American Physiological Society, fall meeting, September 14–17, Sheraton Bon Air Hotel and School of Medicine, University of Georgia, Augusta.